Technical Report No. 6306

ELBOW, 2½" SIZE WITH HALF CYCLE ALTERNATOR

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U. S. ARMY PROSTHETICS RESEARCH LABORATORY
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T.R. No. 6306*

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Scientific Director

Approved:

Director

* Qualified requesters may obtain copies of this report from ASTIA.

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I. INTRODUCTION

An elbow 2½" size with half cycle alternator was designed and developed for use by very short above elbow, shoulder disarticulation and forequarter amputees. The elbow provides the amputee with a means of positively locking the forearm with respect to the arm in 13 separate positions of flexion from the fully extended to the fully flexed position of approximately 5* to 140*. The locking mechanism ~~(Fig. 2)~~ can be engaged or disengaged with the same control motion. Flexion and operation of the terminal device is accomplished by energy transferred from the harness through a cable system to the elbow unit and terminal device. Forearm rotation is permitted between the top portion of the elbow unit and the turntable to which the upper arm shell is fastened. The amount of resistance to rotation is determined by the tension maintained to the attaching bolts.

II. DESIGN

The basic criteria upon which the elbow design was based are the following:

1. The elbow unit should provide for positive locking of the forearm in 13 locking positions.

2. The terminal device should be operable at each selected elbow locking position.

3. A locking mechanism should be provided that can be engaged or disengaged with the same control motion.

4. The energy for operation should be transferable from a harness system through a cable system to the elbow unit and also to the terminal device.

5. The control of the fitted prosthesis should be accomplished with a minimum of motion.

6. Manual control of the forearm rotation should be provided.

7. The elbow unit should have a cosmetically pleasing appearance.

The elbow unit with mechanism is shown in Figs. 1 and 2, and consists of the following components:

1. A housing frame (Fig. 2 (A).

2. Laminating Plate (Fig 2 (A).

3. Half-Cycle Alternator Mechanism Assembly (Fig. 1)

4. Locking Assembly:

   a) Locking Bar (Fig. 1)
   b) Gear Sector (Fig 2) (A)
   c) Rectangular Pivot Bar and Bearing Blocks (Fig 2 (A).
   d) Forearm Laminating Straps (Fig 2 (A).

5. Plastic Elbow Housing Cover (not shown) - Molded plastic cover to provide cosmetic appearance.

The positive locking of the forearm at various levels of operation is provided for by the use of a locking bar and a gear sector which has 13 equally spaced slots.

The gear sector is attached to the laminating straps and held in the frame by a rectangular pivot bar that passes through two bearing blocks which pivot in bearing races provided in the frame (Fig. 2). Whenever the elbow unit has been locked at a selected level of operation any further force applied to the transmission cable will be transferred to the terminal device. The amputee can now operate the terminal device until the alternator locking mechanism has been operated (Fig. 2 (B & C).

Forearm rotation is manual and resistance to rotation is accomplished by friction between the upper face of the elbow housing and the lower frace of the laminating ring. The plates are locked in position by two screw bolts that are used to lock the elbow unit to the upper arm at the desired position.

A molded plastic laminated cap that is fitted over the entire elbow unit provides cosmetic conformity between the elbow unit and the upper arm. This assembly provides the shoulder disarticulation amputee with a prosthesis requiring one less control motion than a standard alternator type elbow lock. The overall prosthesis is a useful cosmetically acceptable assembly.

III. DISCUSSION

Four assemblies of the elbow 2½" size with half cycle alternator have been machined and assembled into complete working units. One unit has been incorporated into a prototype shoulder disarticulation prosthesis for laboratory evaluation. Another unit was presented to the Test Section for cycling tests. The unit was cycled over 200,000 cycles. At the end of the

200,000 cycles the pin on the alternator shaft broke, perhaps due to a brittle pin caused by silver soldering to the lever in assembly. Cycling caused the unit to become much smoother working.

IV. SUGGESTED HARNESS SYSTEM

To provide an adequate functional harness for the shoulder disarticulation amputee, one must take into consideration the lack of control sources otherwise available from humeral motion. The absence of any arm stump makes it exceedingly difficult to provide motion to operate an elbow lock, in addition to forearm lift and terminal device. Because of this lack of motion a substitute must be sought for arm extension to operate the elbow lock.

The basic details of the suggested harness pattern consists of a webbing chest strap which attaches to the anterior portion of the shoulder cap, passes under the axilla on the sound side, crosses the back at midscapular level so as to utilize the maximum available excursion and attaches to the control cable positioned on the back of the shoulder cap. An elastic suspensor strap extends from the top of the shoulder cap, diagonally across the back and attaches to the chest strap at a point toward the sound side and terminates beneath the axilla (Fig. 3). The length of the chest strap is so adjusted as to permit full terminal device operation without bringing the cable into contact with the skin.

Elbow lock operation is provided for by linking the elbow control cable to the chest strap at the anterior portion of the shoulder cap with a piece of 1/2 inch webbing sewn to the chest strap at approximately the center of the chest (Fig. 3). This system provides the amputee with the minimum amount of harness needed to operate the basic controls.

The basic elbow controls are operated through a cable system installed within the confines of the upper arm housing or shell. The component parts consist of: an anchor plate, 3 sheaves, 1 elbow lift, cables with swaged cable end fittings, cable housing and cable housing anchors (Figs. 4 & 5).

V. INSTALLATION OF THE LOCKING MECHANISM CONTROL CABLE

The locking and unlocking system of the elbow unit is controlled by a cable that attaches to the front chest strap, entering into the upper arm shell through a sheave which is fastened at a point approximately slightly lower than the horizontal plane of the chest strap and approximately perpendicular to the upper face of the elbow frame. This cable then passes through the holes provided for in the elbow frame and is attached to the operating lever of the alternator unit (Figs. 4 & 5).

VI. INSTALLATION OF POWER TRANSMISSION CONTROL CABLE

The operation of the terminal device and the selection of the level of operation for the forearm are controlled through a single cable. The anchor unit, consisting of an anchor plate, a short piece of cable and a sheave is positioned at a point which is approximately the center of the upper arm cavity and slightly lower than the horizontal point of exit of the power transmission cable (Figs. 4 &5).

The power transmission cable is attached to the chest strap and enters the upper arm cavity at a point that is horizontal or slightly above the axilla on the sound side, passes through the anchor unit sheave and is in turn attached to a second sheave. The cable which operates the terminal device and is used to lift the forearm is attached to the locking bar of the elbow unit, passes upward through the second sheave, and returns downward and exits from the upper arm cavity at a point that is approximately two inches above the base of the elbow unit and then passes through the elbow lift loop to the terminal device (Figs. 4 & 5).

VII. SEQUENCE OF OPERATION

When making the final adjustments of fitting the operating harness it is necessary that the locking and unlocking cable control be adjusted so that the cable is slack at the relaxed position. Locking and unlocking the elbow unit is accomplished by adducting the sound shoulder causing tension on the alternator cable, forcing the alternator locking bar to rock over into unlocked position.

With the prosthesis at the fully extended and relaxed position the locking bar is engaged in the tooth of the gear and the alternator lock is in the unlocked position.

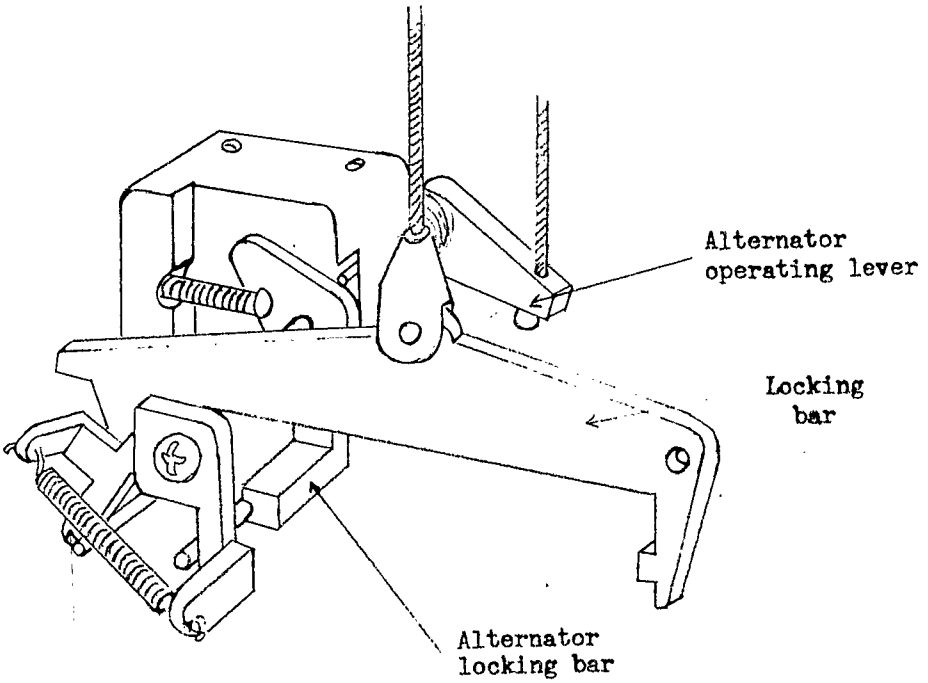
1. An application of force (scapular-abduction of the sound shoulder) causes the locking bar to move out of the gear, allowing the forearm to be lifted to the desired level of operation. At the same time, the movement of the locking bar causes the alternator locking bar to rock over to the locking position against the face of the locking bar.

2. Sudden relaxation of the force, causing the locking bar to move into the teeth of the sector, locking the forearm in the position selected. The alternator locking bar slips into the locking slot, stabilizing the locking bar.

3. Application of a further force is now transmitted directly to the terminal device allowing the amputee to operate his terminal device.

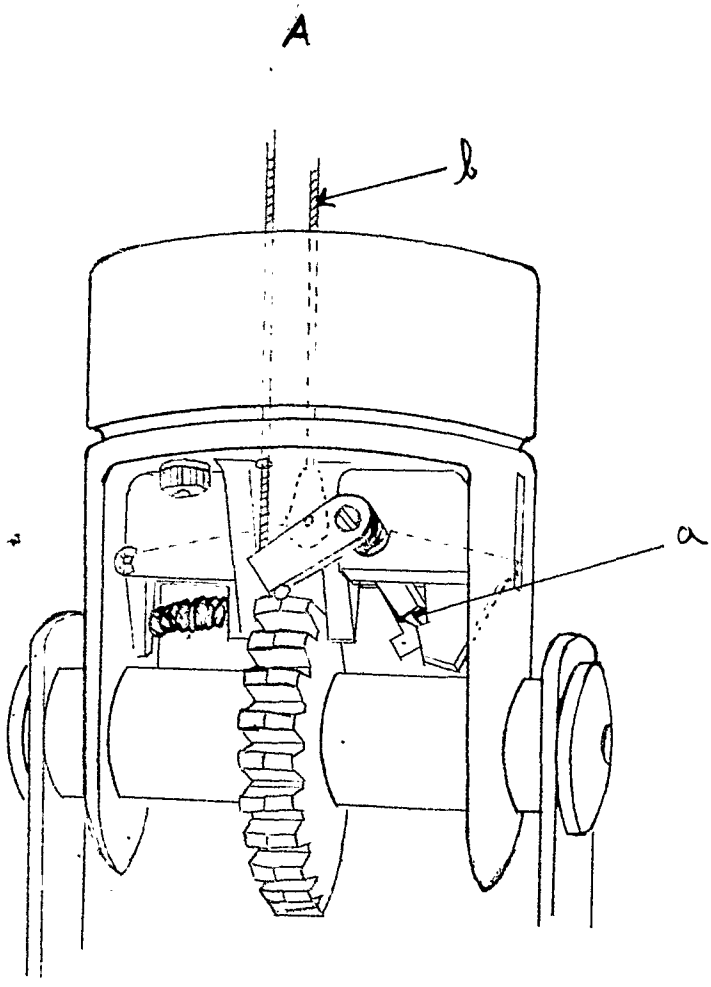
4. Relaxation of the force and a abduction of the sound shoulder causes the alternator locking bar to return to the unlocked position.

5. Application of force causes the elbow locking bar to move out of the gear sector unlocking the elbow unit. A slight relaxation of the force will allow the forearm to drop back to the extended position. A continued application of force allows changing the level of operation, and the prosthesis is now at the original starting sequence of operation.

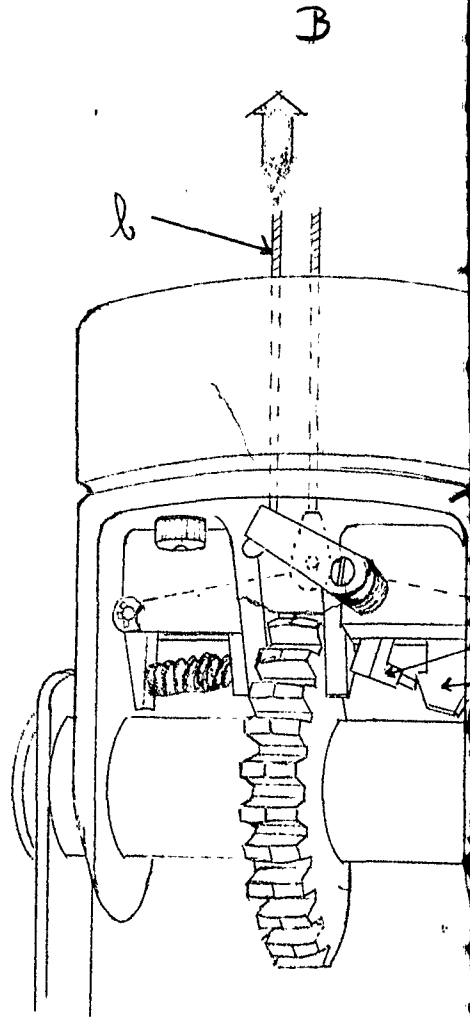


Alternator Assembly and
Locking Bar

Fig 1



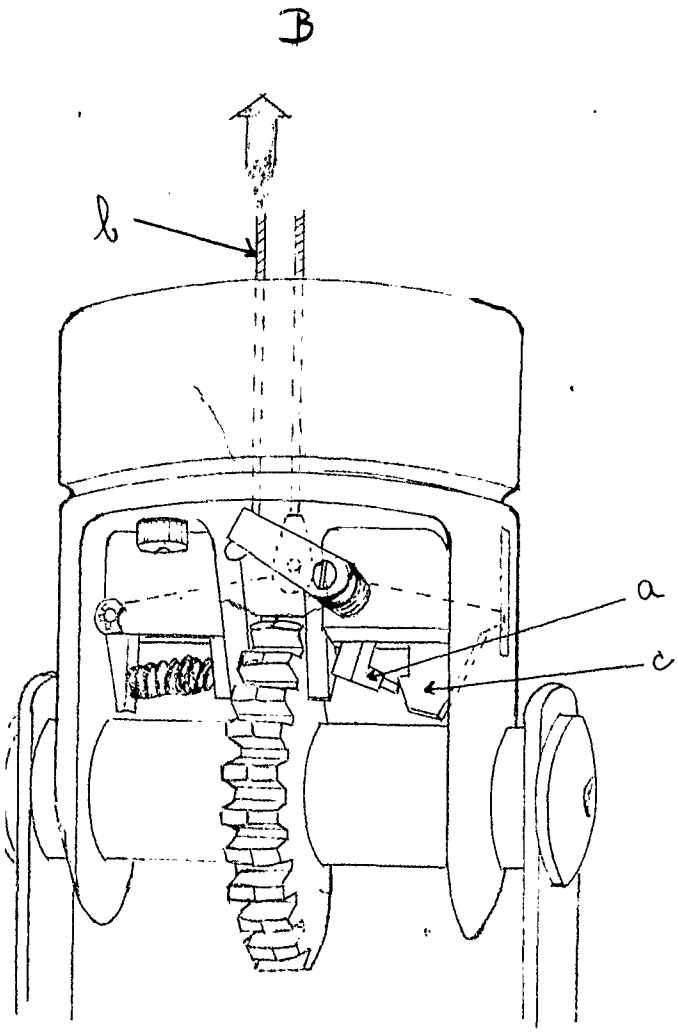
Alterantor operating cable in the relaxed position, alternator locking bar "a" is in the locked position. Applied forces to power transmission cable "b" are transferred to operation of the terminal device.



Force is applied to alternator op cable "b", causing alternator loc to move out of locking position. applied to power transmission cab locking bar "c" out of gear slots ing forearm.

1

Fig 2



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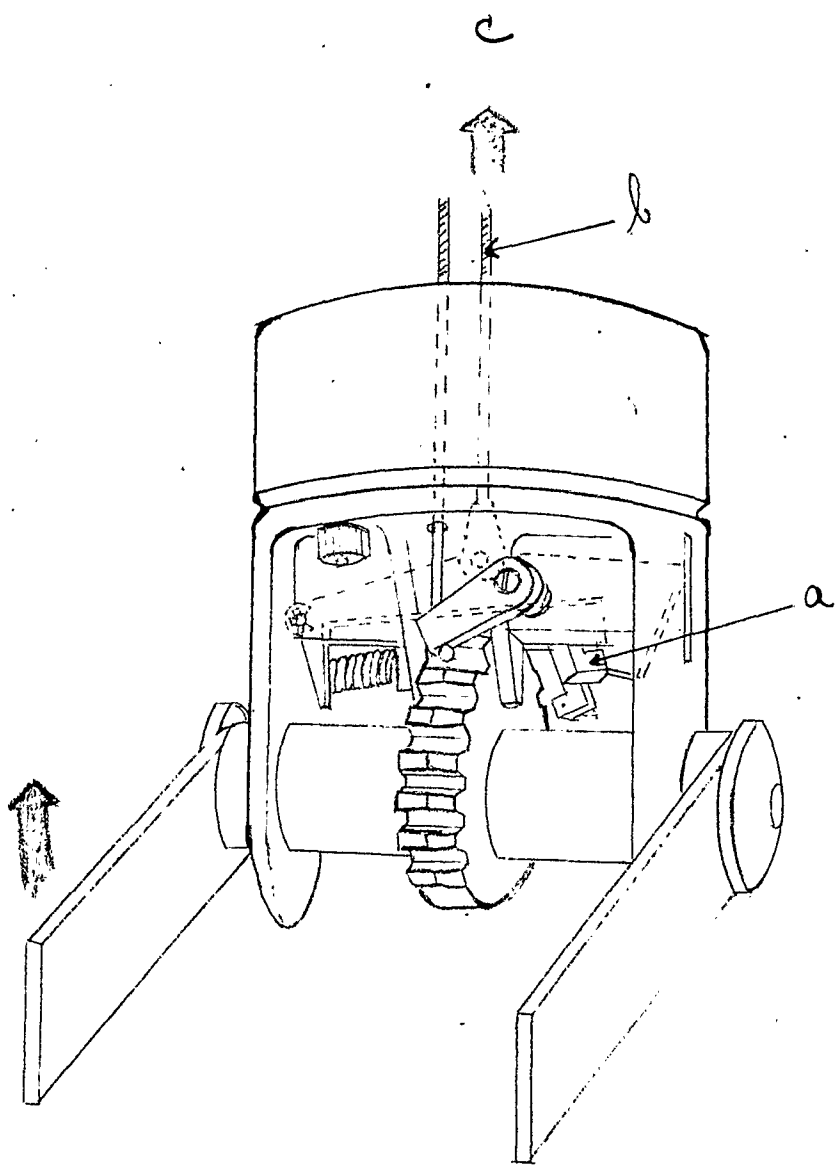

Continued application of force to power transmission cable "b" raises forearm to selected level of operation. Relaxing of force allows locking bar to drop into gear slot locking forearm into position selected. When locking bar drops into position, alternator locking bar "a" automatically moves against face of locking bar, ready for next locking operation.

2

Fig 2

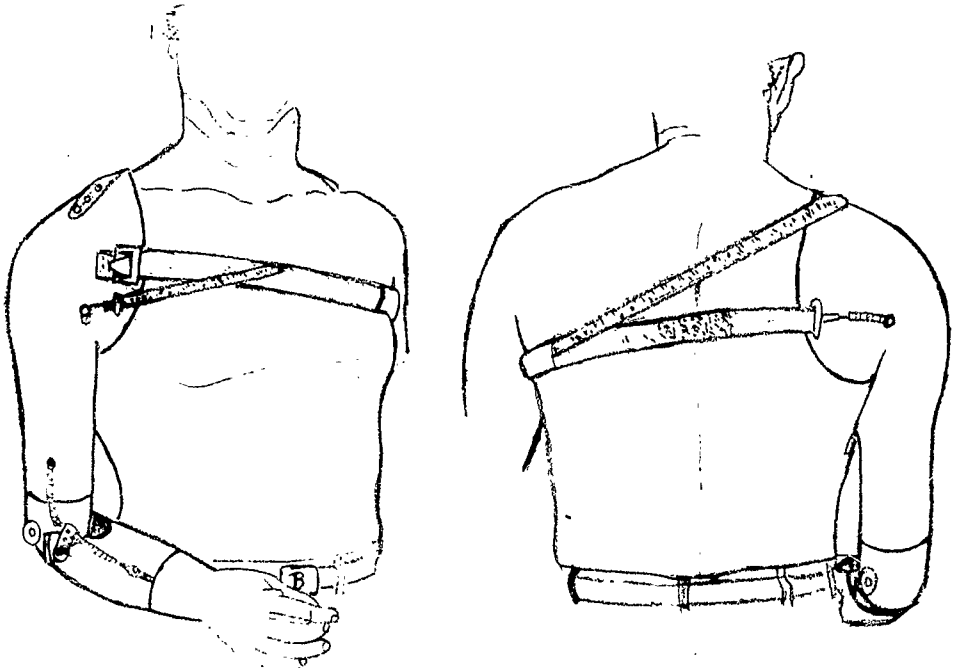

Fig 3

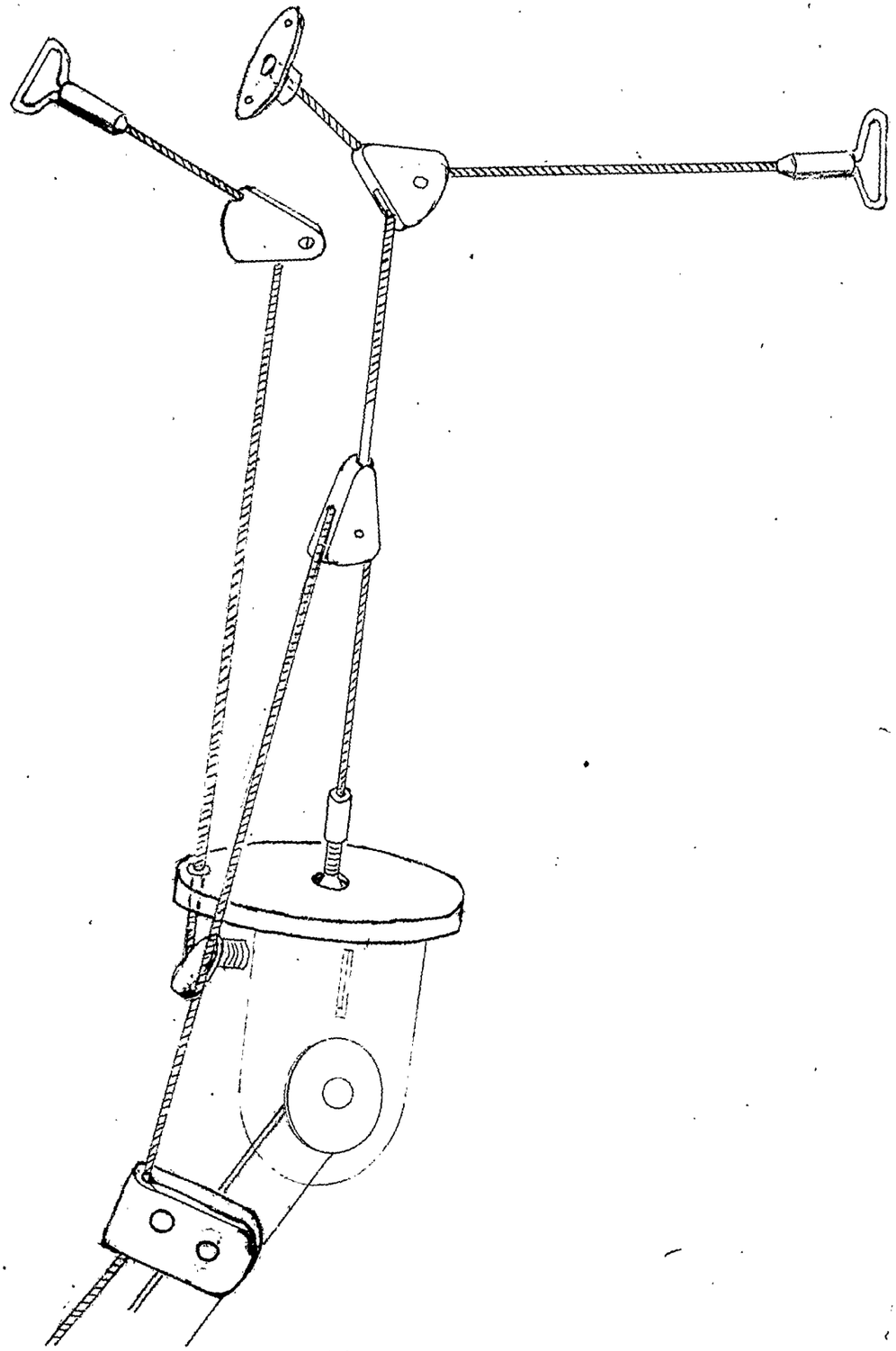

Fig 4

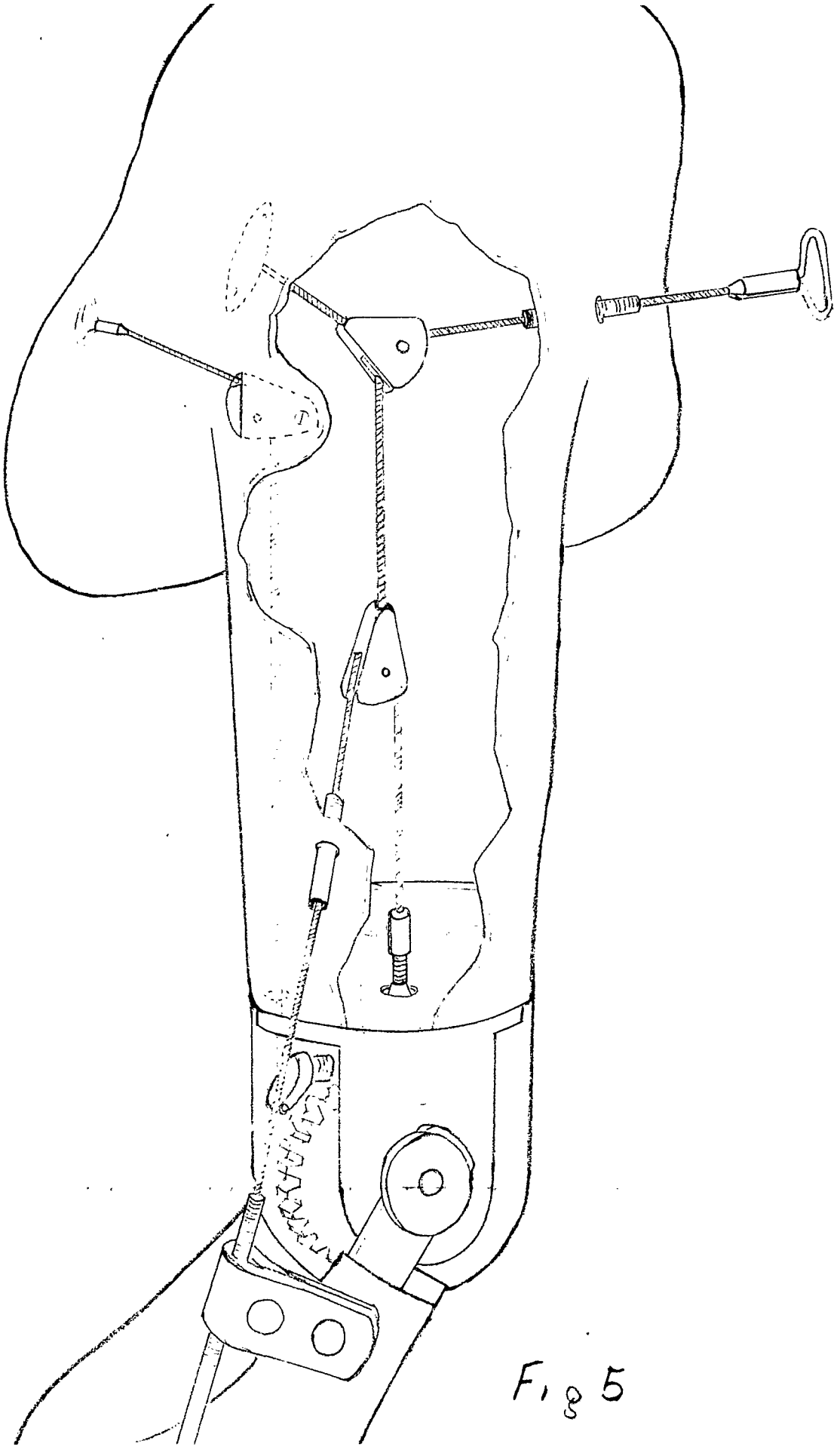

Fig 5

ABSTRACT CARD

TITLE: Elbow, 2½" Size w/Half-Cycle Alternator

AUTHOR (S): T. J.Bushey-V.T.Riblett

AGENCY: USA Prosthetics Res. Lab.
Walter Reed AMC, Washington 12, D. C.

TECH. RPT. 6306 UNCLASSIFIED

Project 6X59-01-001-04

ABSTRACT:

The design and evaluation of an elbow with an alternator mechanism that eliminates one control movement during the lock cycle.

AD _____ # _____

1. Elbow
2. Elbow, Half Cycle
3. AE Elbow
4.

WRAMC FORM 0183 (ONE TIME)
15 MAY 1961

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